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How to Monitor Knapweed Biological Control Root Feeding Insects:

Agapeta zoegana and
Cyphocleonus achates

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Why Monitor Biological Control Agents?

- To detect establishment
- To evaluate spread of insects from initial point of release
- To evaluate impact of insects on the weed population

Common Name: sulphur knapweed moth, yellow-winged knapweed root moth



Figure 1. Adult *A. zoegana*.

Biology—Life Cycle

There is one generation per year. Eggs are laid on the surface of stems and leaves of knapweed, generally in crevices. After hatching, larvae migrate to the root crown area and mine the root. Individual larvae can feed on more than one root. They spend the winter in the larval stage inside the roots. Pupation occurs in the spring within damaged roots. Adults emerge from mid-June to mid-August and live up to 11 days.

Monitoring Methods

There are three methods described for adults and one for larvae. Methods are described from most to least effective. Records of monitoring results should be retained to evaluate spread of insects from initial release point and to evaluate impact.

1. Pheromone Traps:

Pheromone baits and traps are available commercially and require some assembly. Once assembled they resemble a triangle (figure 2). Put the pheromone bait on a pin and place in the center of one of the top sides of each trap. Attach each trap to a metal or wooden stake. The bottom of the trap should be flush with the average height of knapweed plants. Five traps should be placed at each site, at least 15 meters apart throughout the knapweed infestation, and close to the point where insects were released. Pheromones remain effective up to 6 weeks in the field and should be placed in mid-July which is just prior to peak moth flight.



Figure 2. Pheromone trap for monitoring *A. zoegana* adults.

Effectiveness: From our surveys, we recovered adults at 89% of sites sampled.

Efficiency: 5 pheromone traps can be placed per site in 30 minutes, and retrieved in 10 minutes.

Considerations: Traps can be placed prior to moth flight and can be left in the field for up to several months.

2. Visual Transects:

Slowly walk along each of six-50m transects surrounding the insect release point in different directions. Count number of *A. zoegana* seen resting on or near plants. Moths should be recorded that are within a 3' swath on either side of the transect.

Effectiveness: We recovered adult moths at 55% of sites sampled.

Efficiency: Six -50 meter transects can be completed in 30 minutes.

Considerations: Most effective when done between 11 am and 3 pm on warm, calm days with low to no cloud cover during peak moth flight in mid-July.

3. Larval Sampling:

Excavate plants along four transects surrounding the point insects were released. Choose knapweed plants with a minimum diameter of a 7 to 10mm root crown. Excavate with a shovel or pull out a knapweed plant every meter along each transect to a distance of 13 meters, for a total of 52 roots/site. Roots can be dissected in the field or later indoors. Count and record number of larvae found. Larvae are white caterpillars with a brown head (figure 3). They are about 1/2 inch long and have 3 pairs of jointed legs followed by 5 pairs of fleshy prolegs.

Effectiveness: We recovered larvae at 43% of sites sampled.

Efficiency: Collection & dissection of 52 roots takes about 2 hours.

Considerations: Larvae should be collected from May through June. Collector must be able to distinguish between larvae of *A. zoegana* and *Cyphocleonus achates*, which can occur together in the same root.



Figure 3. *A. zoegana* larva.

4. Sweep Netting:

In different directions surrounding the insect release point, take twenty sweeps with cloth net in a horizontal fashion along six transects. Sweeping should be done in the upper portion of the knapweed canopy (figure 4). Examine contents of net for moths after each transect.

Effectiveness: We recovered adults at 38% of sites sampled.

Efficiency: 6 transects (20 sweeps each) can be done in 10 minutes.

Considerations: Most effective when done between 11 am and 3 pm on warm, calm days with low to no cloud cover during peak moth flight.



Figure 4. Using a sweep net for monitoring *A. zoegana*.

Recommendation for monitoring *Agapeta zoegana*: pheromone trapping.

Cyphocleonus achates

Common Name: Knapweed root weevil.



Figure 5. Adult *C. achates*.

Biology—Life Cycle

There is one generation per year. Eggs are laid on the root crown. Larvae mine toward the center of the root soon after hatching. They spend the winter in the larval stage, pupation occurs in spring. Often the larval feeding causes the root to swell, forming a gall. Adults emerge from mid-July to September. Peak emergence occurs in mid-August. Adults feed on knapweed leaves and live 8-15 weeks but do not overwinter.

Monitoring Methods

There are two methods for weevil adults and one for larvae. Methods are described from most to least effective.

Larval Sampling:

Use the same method as for *A. zoegana*. Larvae of the weevil are white, legless grubs about 1/2 inch long and c-shaped (figure 6). Larvae are often found in the upper portion of the root in swollen tissue.



Figure 6. *C. achates* larva.

Effectiveness: We recovered larvae at 36% of sites sampled.

Efficiency: Collection & dissection of 52 roots takes about 2 hours.

Considerations: Larvae should be collected from May through July. Collector must be able to distinguish between larvae of *A. zoegana* and *C. achates* which can occur together in the same root.

Sweep Netting:

Use the same method as for *A. zoegana*.

Effectiveness: We recovered adults at 18% of sites sampled.

Efficiency: 6 transects of 20 sweeps each can be completed in 10 minutes.

Considerations: Same as for *A. zoegana*.



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Visual Searching:

Establish four transects about 10 meters long surrounding the initial insect release point. At four points along each transect, sample a 1 meter square area, (defined by a rigid frame) for number of weevils seen either on plants on the ground or on the underside of leaves. A total of 16 square meters per area is sampled.



Figure 7. Sampling adult *C. achates*.

Effectiveness: We recovered adults at only 9% of sites sampled.

Efficiency: 16-one meter quadrants can be examined in 45 minutes.

Considerations: Same as for *A. zoegana* visual sampling

Recommendation for monitoring *Cyphocleonus achates*: larval sampling.

For more information about biological control of weeds contact your local extension service or your county weed control association.

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